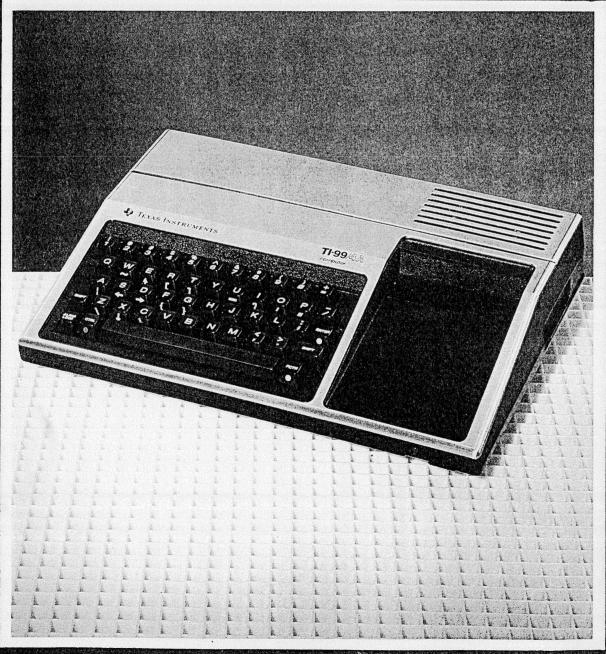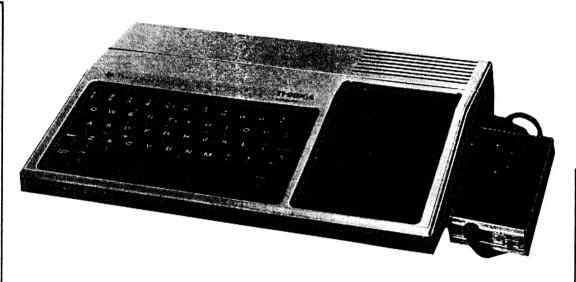# SAMS

COMPUTERFACTS™

TECHNICAL SERVICE DATA

TEXAS INSTRUMENTS TI-99/4A™
MODEL PHC004A
COMPUTER

FEATURES: COMPLETE SCHEMATICS • PRELIMINARY SERVICE CHECKS • TROUBLESHOOTING TIPS •
EASY-READ WAVEFORMS • REPLACEMENT PARTS LISTS • SEMICONDUCTOR CROSS-REFERENCE

CC 2 — TEXAS INSTRUMENTS TI-99/4A MODEL PHC004A

CC 2 — TEXAS INSTRUMENTS TI-99/4A MODEL PHC004A

TI-99/4A MODEL PHC004A

PRELIMINARY SERVICE CHECKS
ENCLOSED

SAFETY PRECAUTIONS
See page 13.

INDEX

SAMS™ **Howard W. Sams & Co., Inc.**
4300 West 62nd Street, P.O. Box 7092, Indianapolis, Indiana 46206 U.S.A.

COMPUTERFACTS-OF-THE-MONTH SET NO. CF1 FOLDER CC 2

MAIN BOARD

A15

CD0 1.20V 1.32V D0
CD1 1.02V 1.17V D1
CD2 .98V 1.53V D2
CD3 1.18V 1.31V D3
CD4 1.13V 1.31V D4
CD5 1.24V 1.50V D5
CD6 1.61V 1.51V D6
CD7 1.84V 1.36V D7

SN74LS245N
⊕ U614
TRANSCEIVER
4.17V 2.95V 8
DBIN 5.14V

PART OF
⊕ U604 SN74LS04N

DATA
Q500 BUS SWITCH
R500
2 NC 10 9 8 7 6 5 4 3
1500 1500 1500 1500 1500 1500 1500 1500

R519 5600 .54V
2.17V
R522 360
R521 150
CR502 1N4148
R520 10
CR501 1N4148
62 63
2 11.84V 8 5.14V

CD8 1.32V D0
CD9 1.28V D1
CD10 1.57V D2
CD11 1.30V D3
CD12 1.31V D4
CD13 1.72V D5
CD14 1.49V D6
CD15 1.32V D7

SN74LS244N
⊕ U616
TRANSCEIVER
1.65V
8 5.14V

J500
GROM PORT
17 D0
15 D1
13 D2
11 D3
9 D4
7 D5
5 D6
3 D7

24 A3
30 A4
28 A5
26 A6
22 A7
20 A8
18 A9
16 A10
14 A11
12 A12
10 A13
23 A14B
34
21
31
33
25 DBIN
27
6 CRU IN
4 CRU CLK
32 WE
8 A15 CRU
1 61

A0 2.79V 3.46V
A1 .02V 4.29V NC
A2 .02V 4.29V
MEMEN 2.45V 4.30V
R515 1000 3.05V
5.14V 4.29V
R527 1000

SN74LS138N
⊕ U504
DECODER
4.28V NC
4.33V NC
9
5.14V

J500
GROM PORT
2
35
36
19
29
5 5.14V
−5.15V

A14B
DBIN
GROM CLK
W500
R516 3300
R502 1000
R517 2200
MB4 MBE
ROMEN DBIN
8 5.14V

SN74LS373N
⊕ U615
LATCH
CD8 D0
CD9 D1
CD10 D2
CD11 D3
CD12 D4
CD13 D5
CD14 D6
CD15 D7
4.18V 8
A15 5.14V

SEE PINOUTS, TERMINAL
GUIDES AND SCHEMATIC
NOTES PAGES 11, 26.
DBIN
LINE IDENTIFICATIONS ASSIGNED FOR REFERENCE

A PHOTOFACT STANDARD NOTATION SCHEMATIC
WITH CIRCUITRACE
© Howard W. Sams & Co., Inc. 1984

D0 8
D1 7
D2 6
D3 5
D4 4
D5 3
D6 2
D7 1

CD2155NL ⊕ U500 GROM 0
CD2156NL ⊕ U501 GROM 1
CD2157NL ⊕ U502 GROM 2

8 5.14V
14 2.42V
A14B
DBIN 1.69V
16
15 −.74V
13 −.49V
4.73V
2.62V

C505 .1
CR500 1N4148
R501 270
5 −5.15V

A15 4.18V 4.27V NC
A3B 47V 4.30V
A4B .66V 4.34V
A5B 33V 4.27V
4.28V
A5B 4.28V
4.06V
DBIN 1.69V
SN74LS138N
⊕ U505
DECODER
4.15V
R513 1000 (2200)
9 5.14V

PART OF
⊕ U506 SN74LS03N
5.06V

PART OF
⊕ U506 SN74LS03N
SBE .13V

PART OF
⊕ U508 SN74LS04N
4.73V
R518 2200
8 5.14V

PART OF
⊕ U506 SN74LS03N
4.82V
R503 1000
R508 4700
9 5.14V
9 5.14V

PART OF
⊕ U507 SN74LS32N
4.71V
4.17V CSW

PART OF
⊕ U508 SN74LS04N
4.52V

R504 4700
8 5.14V

WE
CSR
CSW
ROMEN
DBIN

D0 2
D1 7
D2 15
D3 13
D4 12
D5 11
D6 8
D7 11

SN94624N
⊕ U511
SOUND GENERATOR
SYS RDY 4.82V
WE 4.17V
SGC CLK 2.62V
W502
GROM CLK
74V 4.35V

WAVEFORM APPEARS AFTER
THE FCTN AND = KEYS
ARE PRESSED
2.62V H(1)
.4V .5ms 2.4V
SND OUT
65
C502 .1 C503 100μF
64
R511 10
5.12V
L500
C501 .1
8 5.14V

5V 2ms 0V
4.8V 1μs 0V

R510 330
66 SPEECH

CABLING:
HEAVY LINE REDUCES
USE OF MULTIPLE LINES
SYS RDY

4.3V 2μs 0V
CD0 24 D0
CD1 23 D1
CD2 22 D2
CD3 21 D3
CD4 20 D4
CD5 19 D5
CD6 18 D6
CD7 17 D7

A14
CSR
CSW
VDP INT

TMS9
⊕ U
CC
GRA
VI
DIS

2.37V
4.34V
4.71V
3.88V
5.11V

R102 470
C103 100μF
C102 .001
L101
67 SND IN
10 5.13V

C100 56pF
Y100 10.7MHz
L107
R101 470K
L100
C101 12pF
68
1.50V
2.62V
39
40
15V 2μs 0V

RST1 H 4.31V
34

SEE LINE DEFINITIONS ON PAGE 13

TEXAS INSTRUMENTS
TI-99/4A MODEL PHC004A

MAIN BOARD

SERVICE CHECKS

SEE INTERCONNECTING DIAGRAM, PLACEMENT CHART, AND PHOTOS TO MATCH THE NUMBER IN THE CIRCLES WITH THOSE IN THE FOLLOWING DATA FOR SERVICE CHECKS TO BE PERFORMED.

① **RF MODULATOR**

(a) Power computer and verify the power indicator LED is lit. NOTE: If the power indicator LED is not lit, refer to the "Power Supply Check" section.

(b) Verify the channel select switch is on the same channel as the monitor, channel 3 or 4.

(c) Verify the TV/modulator switch is in modulator position.

(d) Check for bad connections and improper hook-up at the monitor and at the computer.

(e) If the computer still does not come up when powered, check the RF Modulator by substitution.

② **POWER SUPPLY**

(a) Power computer and measure the AC voltages, from the secondary of the Power Transformer (T1), on the power supply board. If there is no AC voltage, replace AC adaptor.

(b) Disconnect P2 from power supply board. Measure the DC voltages at P2.

(c) Measure the Regulator B + voltage (21.5V) at L6. If the voltages are not present or are incorrect, replace or repair the power supply board.

③ **MAIN BOARD**

(a) Computer does not come up when powered. Check for −5.15V at pin 1, 5.14V at pins 2, 33, 59 and 64, and 11.84V at pin 27 of the Microprocessor IC U600. Verify the Timing Generator is functioning, by checking for pulses on pins 8, 9, 25, and 28 of the Microprocessor IC U600 using a logic probe.

(b) No sound, substitute the Sound Generator IC U511.

(c) Video problems, substitute the Color Graphics Video Display IC U100.

(d) Monitor remains blank when the computer is turned On. Substitute a monitor known to be good. Substitute GROM IC U500 and Video IC U100.

(e) Monitor displays insert cartridge after pressing the number 1 key. Substitute GROM IC U501.

(f) If there is no line feed when pressing the ENTER key, substitute GROM IC U502.

(g) Remote control line will not turn on CS1. Remove power to computer and check the resistance from the emitter to collector of Q401. The resistance should read low during the time the recorder is suppose to be running and open when not running. If these readings are correct check the cassette recorder.

(h) Check the resistance reading from the emitter to collector of Q403 if CS2 will not turn On.

(i) Keyboard fails to function. Disconnect the keyboard connector P100. Power computer and check the voltage and logic readings at J100. If the readings are correct, check the keyboard.

④ **KEYBOARD**

Substitute the keyboard or locate the bad key and clean the key switch with switch cleaner.

TEST EQUIPMENT AND TOOLS

TEST EQUIPMENT

Digital Volt/Ohm Meter
Logic Probe

TOOLS

Phillips Screwdriver
Small Screwdriver
Soldering Iron
Switch Cleaner

REPLACEMENT PARTS

AC Adaptor Model AC9500

IC	TYPE NO.
U100	TMS9918A
U500	CD2155NL
U501	CD2156NL
U502	CD2157NL
U511	SN94624N

DISASSEMBLY INSTRUCTIONS

CABINET BOTTOM REMOVAL

Remove the On-Off knob. Remove Phillips screws 1 thru 7 (See Figure 1) from the bottom and remove the cabinet bottom.

POWER SUPPLY BOARD REMOVAL

Remove Phillips screws 7 and 8 (See Figure 2) from the power supply board. Lift the board up, unplug the cable going to the main board and remove the power supply board.
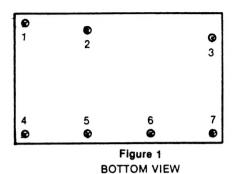
MAIN BOARD REMOVAL

Remove Phillips screws 1, 2 and 3 (See Figure 2) holding the main board. Lift up the main board, unplug the keyboard and remove the main board.

To remove the shield, remove the two metal clamps (See Figure 2) and unplug the cartridge plug. Remove Phillips screws and nuts 4, 5 and 6 (See Figure 2) and remove the top and bottom shield.

KEYBOARD REMOVAL

Remove Phillips screws 9 thru 12 (See Figure 2) holding the keyboard. Unplug the keyboard from the main board and remove the keyboard.

Figure 1
BOTTOM VIEW

Metal Clamps

Figure 2
BOTTOM VIEW

TEXAS INSTRUMENTS
TI-99/4A MODEL PHC004A

PRELIMINARY SERVICE CHECKS

This data provides the user with a time-saving service tool which is designed for quick isolation and repair of computer malfunctions.

Check all interconnecting cables for good connection and correct hook-up before making service checks.

Disconnect all peripherals except the monitor from the computer to eliminate possible external malfunctions.

Replacement or repair of the power supply board, RF modulator, keyboard, or connectors may be necessary after the malfunction has been isolated.

GENERAL OPERATING INSTRUCTIONS

POWER UP

When the computer is turned On, the main title screen will be displayed on the monitor. Press any key and a menu will be displayed.

The menu choices will be determined by the Solid State Cartridge used. Turn the computer Off when inserting or removing a Solid State Cartridge. Refer to the menu and press the key for the desired function.

For instructions to load and save programs on cassette tape, refer to "Cassette Operation". Run a basic program by typing RUN and press the ENTER key. Stop a program by holding down the FCTN key and press the number 4 key. The computer will return to the basic mode and the program will be unaffected. Reset the computer by holding down the FCTN key and press the = key. The computer will return to the main title screen and any program in memory will be lost.

CASSETTE OPERATION

Connect the cassette cable to the cassette plug on the rear of the computer. Connect the plug with the red wire to the Mic input on the recorder, the plug with the white wire to the Earphone output on the recorder and the plug with the black wire to the Remote input on the recorder.

NOTE: The remote control may not work on some recorders.

Set the Tone control on the recorder to Maximum and the volume control to mid-range. Verify the ALPHA LOCK key, on the computer, is in the down position and put the computer in BASIC mode.

Save a program by typing SAVE CS1, press the ENTER key and follow the instructions that appear on the monitor screen.

Load a program by typing OLD CS1, press the ENTER key and follow the instructions that appear on the monitor screen. If a program will not load, set the Volume control to a different level and try loading the program again.

When using two recorders, the recorder connected to the three plug section of the cable will be CS1 and the recorder connected to the two plug section will be CS2. CS2 can be used for saving programs or data only. Save a program on CS2 by typing SAVE CS2, press the ENTER key and follow the instructions that appear on the monitor.

POWER SUPPLY BOARD

VIII

RF MODULE
J201

3c
U100

3d
U500

3e
U501

3f
U502

3b
U511

CARTRIDGE
PORT
PIN 1
J500

3g
Q401
E   C

3h
Q403
E   C

CASSETTE
J400

TEXAS INSTRUMENTS
TI-99/4A MODEL PHC004A

J300
JOYSTICK

J100
PIN 1
KEYBOARD

3i

U600
PIN 1

3a

−5V   12V   ⏚   5V

U601
PIN 1

J100A
PIN 2
I/O PORT

PLACEMENT CHART

TAPE CASSETTE INPUT

COLOR MONITOR

RF MODULATOR

TV/MODULATOR SWITCH — ①c

CHANNEL SELECT SWITCH — ①b

① MODULATOR

J201

JOYSTICK INPUT

J300

J400

Q401 ③g
Q403 ③h

CARTRIDGE PORT

③d ③e ③f ③b
SOUND
GROM

③a MICROPROCESSOR

ROM

③ MAIN BOARD

③c VIDEO
RAM
I/O

③i KEYBOARD INPUT — J100

DC INPUT

④ KEYBOARD

P2 DC OUTPUT ②b

② POWER SUPPLY

②c L6

POWER SWITCH — S1

T1 — 120VAC

I/O PORT

TERMINAL GUIDE PIN VIEW — J400

MEASUREMENTS TAKEN IN POWER-UP MODE WITH A DIGITAL VOLT/OHM METER.

LOGIC PROBE DISPLAY
L=LOW
H=HIGH
P=PULSE

Pin		Volt	Pin		Volt
1	H	5.14V	23	H	GND
2	L	-.13V	24	P	3.41V
3	H	-4.50V	25	L	GND
4	L	5.13V	26	P	3.84V
5	P	-.33V	27	H	GND
6	P	2.66V	28	H	4.29V
7	P	.66V	29	P	.09V
8	P	1.58V	30	P	2.81V
9	H	1.56V	31	P	2.37V
10	P	1.55V	32	P	2.45V
11	P	.47V	33	H	2.37V
12	P	2.02V	34	P	2.20V
13	H	2.20V	35	P	1.36V
14	P	5.13V	36	P	1.51V
15	P	2.32V	37	P	1.32V
16	P	1.42V	38	P	1.51V
17	P	2.65V	39	P	1.50V
18	P	2.73V	40	P	1.53V
19	P	1.96V	41	P	1.17V
20	L	-.09V	42	L	-.53V
21	L	GND	43	P	1.31V
22	P	4.00V	44	L	-5.15V
				L	-.75V

P100A

CASSETTE — J400

CARTRIDGE PORT
ODD PINS 35
EVEN PINS 36
P100A
ODD NUMBERED PINS ON FOIL SIDE

Q401 ③g
Q403 ③h
③b U511
③f U502
③e U501
③d U500
③a

U600
64

Y600 48 MHZ
U601 TIMING GENERATOR
PIN 1
CHECK FOR A PULSE AT PINS 8,9,25,28 OF U600.

③c U100

③ MAIN BOARD

③i J100
4.87V P H 5.14V
1.60V 4.87V P

H 5.14V

④ KEYBOARD

J300 JOYSTICK

TERMINAL GUIDE PIN VIEW — J300

RF MODULATOR
J201
TERMINAL GUIDE FRONT VIEW
12V
.54V
1.95V
J201

① RF MODULATOR

② POWER SUPPLY BOARD

T1 — 120VAC
WHITE
17.85VAC
BLACK
RED
-5V 12V 5V
-5V12V 5V
8.55VAC
21.5VDC
②b ②c
P2
L6 S1
②b 5V 8.55VAC 21.5VDC

CC 2
TEXAS INSTRUMENTS
TI-99/4A MODEL PHC004A

A PHOTOFACT STANDARD NOTATION SCHEMATIC
WITH **CircuiTrace**
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KEYBOARD & MAIN BOARD

SEE LINE DEFINITIONS ON PAGE

WAVEFORM TAKEN WHILE PRESSING THE 2 KEY

WAVEFORM TAKEN WHILE PRESSING THE Q KEY

WAVEFORM TAKEN WHILE PRESSING THE 6 KEY

WAVEFORM TAKEN WHILE PRESSING THE Y KEY

WAVEFORM TAKEN WHILE PRESSING THE N KEY

WAVEFORM TAKEN WHILE PRESSING THE A KEY

WAVEFORM TAKEN WHILE PRESSING THE H KEY

WAVEFORM TAKEN WHILE PRESSING THE Z KEY

WAVEFORM TAKEN WHILE PRESSING THE ALPHA LOCK KEY AND THE 2 KEY

WAVEFORM TAKEN WHILE LOADING A PROGRAM FROM TAPE (HEADER SIGNAL)

WAVEFORM TAKEN WHILE SAVING A PROGRAM TO TAPE (HEADER SIGNAL)

WAVEFORM TAKEN WHILE LOADING A PROGRAM FROM TAPE (HEADER SIGNAL)

WAVEFORM TAKEN WHILE LOADING A PROGRAM FROM TAPE (HEADER SIGNAL)

TMS9901NL U300 I/O CONTROL

SN74LS156N U302 DECODER

TMS9904ANL U601 TIMING GENERATOR

TMS U6 MICROPR

Y600 48MHz

Q400 BUFFER

Q402 DRIVER

Q404 LED DRIVER

TIL119 U401

TIL119 U402

Q300 JOYSTICK CONTROL 1

Q301 JOYSTICK CONTROL 2

PART OF U602 SN74LS04N

PART OF U400 RC4558P

PART OF U400 RC4558P

LINE IDENTIFICATIONS ASSIGNED FOR REFERENCE

SEE PINOUTS, TERMINAL GUIDES AND SCHEMATIC NOTES PAGES 11, 26.

CABLING: HEAVY LINE REDUCES USE OF MULTIPLE LINES

JOYSTICK PORT

TAPE CASSETTE

TEXAS INSTRUMENTS

MAIN BOARD   TI-99/4A MODEL PHC004A

POWER SUPPLY

SEE PINOUTS, TERMINAL GUIDES AND SCHEMATIC NOTES PAGES 11, 26.

A PHOTOFACT STANDARD NOTATION SCHEMATIC
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SEE LINE DEFINITIONS ON PAGE 13

MAIN BOARD

CABLING:
HEAVY LINE REDUCES USE OF MULTIPLE LINES

SEE PINOUTS, TERMINAL GUIDES AND SCHEMATIC NOTES PAGES 11, 26.

LINE IDENTIFICATIONS ASSIGNED FOR REFERENCE

A Howard W. Sams CIRCUITRACE Photo

NOTE THERE IS NO GROUND ON KEYBOARD

38 37 35 43 32 42 30 41 31 40 36 39 33 44 34

TEXAS INSTRUMENTS
TI-99/4A MODEL PHC004A

S14 S1 S13 S12 S23 S24 S34 S25 S35 S45
S2 S46
S3 S36
S15 S37
S4 S26
S5 S38
S16 S27
S6 S39
S17 S47
S7 S28
S8 S40
S18 S41
S9 S29
S10 S42
S19 S30
S11 S20 S21 S22 S33 S32 S31 S44 S43 S48

* LOCATED ON OTHER SIDE OF BOARD

POWER SUPPLY BOARD GridTrace LOCATION GUIDE

Component	Location
C1	J-10
C2	J-10
C3	D-7
C4	F-11
C6	C-11
C7	J-8
C8	G-7
C9	D-9
C10	C-6
C11	E-2
C12	H-4
C13	E-1
C14	B-7
C15	C-5
C16	I-3
C17	E-11
C18	F-11
CR1	H-10
CR2	I-10
CR3	I-10
CR4	I-10
CR5	H-4
CR7	I-4
CR8	B-4
CR9	G-3
CR10	E-11
L1	F-11
L2	G-11
L3	D-2
L4	H-8
L5	I-8
L6	A-10
P/J2	F-4
Q1	F-5
Q2	H-5
R1	K-8
R2	H-5
R3	G-3
R4	E-4
R5	E-3
R6	G-2
R7	A-2
R8	B-2
R9	H-4
R10	H-5
R11	I-5
R12	I-5
R13	J-15
R14	J-3
R15	J-15
R16	K-11
R17	C-8
R18	J-8
R19	F-2
S1A	H-2
U1	K-5
U2	K-5
U3	K-3
U4	K-5
W1	K-5
W2	
W3	
W4	

TEXAS INSTRUMENTS
TI-99/4A MODEL PHC004A

Callouts (right board): PIN 1 U1 21.5V, 1, 14, 27, 12, 26, 16, 28, 15, 11, PIN 1 U2, 13
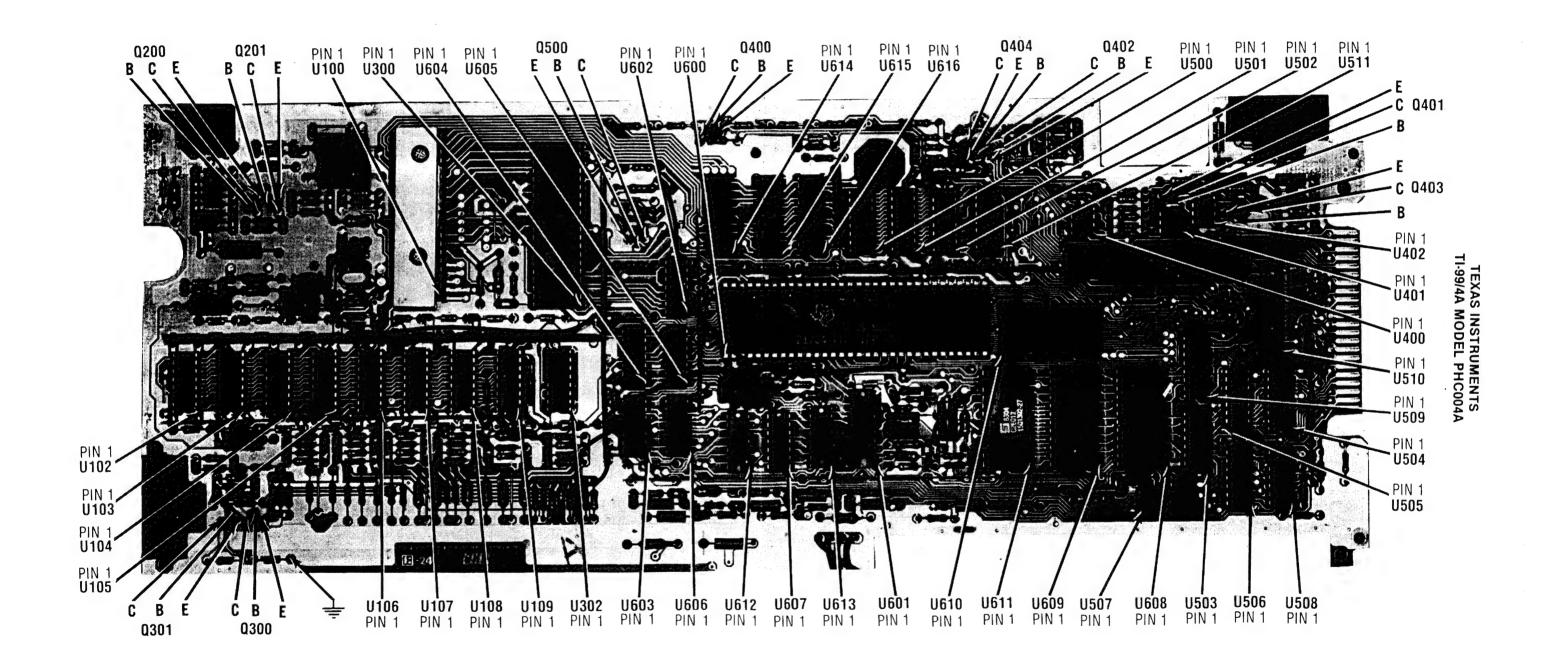Callouts (lower): E, Q2, C, B, C, Q1, B, E, 17, U3, PIN 1, 18, PIN 1, U4, 16, 29

POWER SUPPLY BOARD   A Howard W. Sams **GRIDTRACE**™ Photo
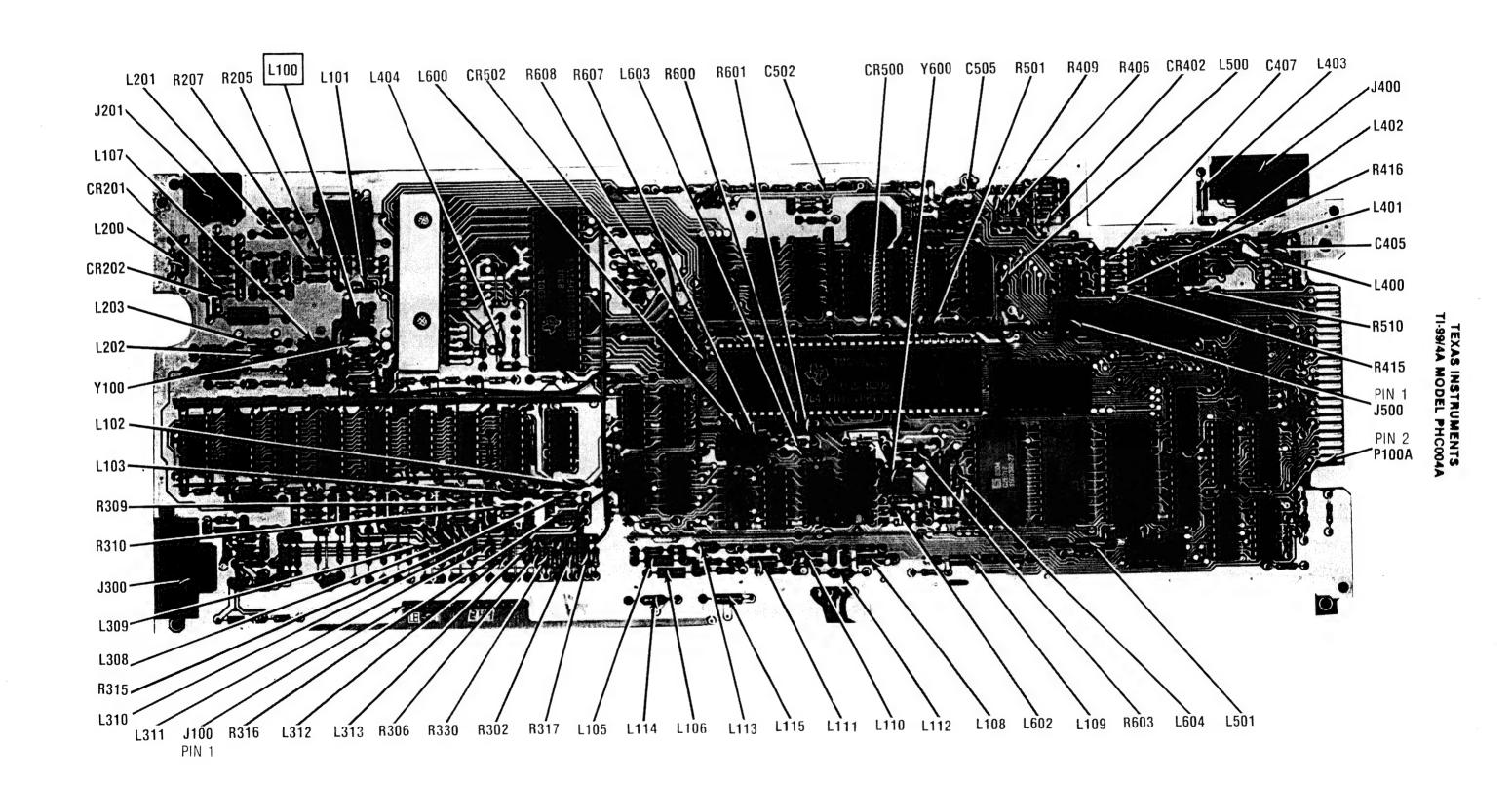
A Howard W. Sams **CIRCUITRACE**® Photo   POWER SUPPLY BOARD

Q200
B C E

Q201
B C E

PIN 1
U100

PIN 1
U300

PIN 1
U604

PIN 1
U605

Q500
E B C

PIN 1
U602

PIN 1
U600

Q400
C B E

PIN 1
U614

PIN 1
U615

PIN 1
U616

Q404
C E B

Q402
C B E

PIN 1
U500

PIN 1
U501

PIN 1
U502

PIN 1
U511

E
C Q401
B

E
C Q403
B

PIN 1
U402

PIN 1
U401

PIN 1
U400

PIN 1
U510

PIN 1
U509

PIN 1
U504

PIN 1
U505

PIN 1
U102

PIN 1
U103

PIN 1
U104

PIN 1
U105

C B E
Q301

C B E
Q300

U106
PIN 1

U107
PIN 1

U108
PIN 1

U109
PIN 1

U302
PIN 1

U603
PIN 1

U606
PIN 1

U612
PIN 1

U607
PIN 1

U613
PIN 1

U601
PIN 1

U610
PIN 1

U611
PIN 1

U609
PIN 1

U507
PIN 1

U608
PIN 1

U503
PIN 1

U506
PIN 1

U508
PIN 1

TEXAS INSTRUMENTS
TI-99/4A MODEL PHC004A

−5.14V 11.83V 5.13V

75 68 65 6 3 10 19 20 62 52 83 63 24 64 56 61 48 49 53 54 45 46 47 66

73 74 72 71 70 69 67 57 58 59 60 32 33

51 50 82 80 81 77 78 79 76

35 36 34 38 30 44 40 31 37 39 43 42 41 22 4 90 7 23 25 5 8 21 2 9

−5.21V 5.16V −5.15V 5.14V 11.84V 5.14V

MAIN BOARD

A Howard W. Sams CIRCUITRACE Photo

MAIN BOARD

TEXAS INSTRUMENTS
TI-99/4A MODEL PHC004A

CC 2

TEXAS INSTRUMENTS
TI-99/4A MODEL PHC004A

SCHEMATIC NOTES

—✱— Circuitry not used in some versions
--- Circuitry used in some versions
⊖ See parts list
⏚ Ground

Item numbers in rectangles appear in the alignment/adjustment instructions.

Supply voltage maintained as shown at input.

Voltages measured with digital meter.

Voltages and Waveforms taken with computer in Power Up mode (Main title screen displayed) unless otherwise noted. Waveforms taken with triggered scope and Sweep/Time switch in Calibrate position, scope input set for DC coupling on "O" reference voltage waveforms. Switch to AC input to view waveforms after DC reference is measured when necessary. Each waveform is 9 cm width with DC reference voltage given at the bottom line of each waveform. Time in μsec. per cm, given with p-p reading at the end of each waveform.

Terminal identification may not be found on unit.

Resistors are 1/2W or less, 5% unless noted.

Value in ( ) used in some versions.

NOTE: Logic probe readings taken with computer in Power Up mode (Main title screen displayed) unless otherwise noted.

Logic Probe Display
L = Low
H = High
P = Pulse
* = Open (no light on)
(1) Probe will show P when sound is being produced.
(2) Probe will show P when the 6 key is pressed.
(3) Probe will show P when the Y key is pressed.
(4) Probe will show P when the H key is pressed.
(5) Probe will show P when the N key is pressed
(6) Probe will show P when the Z key is pressed.
(7) Probe will show P when the Q key is pressed.
(8) Probe will show P when the A key is pressed.
(9) Probe will show P when the 2 key is pressed.
(10) Probe will show P when saving program to tape.
(11) Probe will show P when loading program from tape.

GENERAL OPERATING INSTRUCTIONS

POWER UP

When the computer is turned On, the main title screen will be displayed on the monitor. Press any key and a menu will be displayed.

The menu choices will be determined by the Solid State Cartridge used. Turn the computer Off when inserting or removing a Solid State Cartridge. Refer to the menu and press the key for the desired function.

For instructions to load and save programs on cassette tape, refer to "Cassette Operation". Run a basic program by typing RUN and press the ENTER key. Stop a program by holding down the FCTN key and press the number 4 key. The computer will return to the basic mode and the program will be unaffected. Reset the computer by holding down the FCTN key and press the = key. The computer will return to the main title screen and any program in memory will be lost.

CASSETTE OPERATION

Connect the cassette cable to the cassette plug on the rear of the computer. Connect the plug with the red wire to the Mic input on the recorder, the plug with the white wire to the Ear-phone output on the recorder and the plug with the black wire to the Remote input on the recorder.

NOTE: The remote control may not work on some recorders.

Set the Tone control on the recorder to Maximum and the volume control to mid-range. Verify the ALPHA LOCK key, on the computer, is in the down position and put the computer in BASIC mode.

Save a program by typing SAVE CS1, press the ENTER key and follow the instructions that appear on the monitor screen.

Load a program by typing OLD CS1, press the ENTER key and follow the instructions that appear on the monitor screen. If a program will not load, set the Volume control to a different level and try loading the program again.

When using two recorders, the recorder connected to the three plug section of the cable will be CS1 and the recorder connected to the two plug section will be CS2. CS2 can be used for saving programs or data only. Save a program on CS2 by typing SAVE CS2, press the ENTER key and follow the instructions that appear on the monitor.

DISASSEMBLY INSTRUCTIONS

CABINET BOTTOM REMOVAL

Remove the On-Off knob. Remove Phillips screws 1 thru 7 (See Figure 1) from the bottom and remove the cabinet bottom.

POWER SUPPLY BOARD REMOVAL

Remove Phillips screws 7 and 8 (See Figure 2) from the power supply board. Lift the board up, unplug the cable going to the main board and remove the power supply board.

MAIN BOARD REMOVAL

Remove Phillips screws 1, 2 and 3 (See Figure 2) holding the main board. Lift up the main board, unplug the keyboard and remove the main board.

To remove the shield, remove the two metal clamps (See Figure 2) and unplug the cartridge plug. Remove Phillips screws and nuts 4, 5 and 6 (See Figure 2) and remove the top and bottom shield.

KEYBOARD REMOVAL

Remove Phillips screws 9 thru 12 (See Figure 2) holding the keyboard. Unplug the keyboard from the main board and remove the keyboard.

Figure 1
BOTTOM VIEW

Metal Clamps

Figure 2
BOTTOM VIEW

BLOCK DIAGRAM

TEXAS INSTRUMENTS
TI-99/4A MODEL PHC004A

LOGIC (Continued)

PIN NO.	IC U614	IC U615	IC U616	LEAD	Q200	Q201	Q300	Q301
1	P	P	P	E	P	P	H	P
2	P	P	P	B	P	P	H	P
3	P	P	P	C	P	H	H	H
4	P	P	P					
5	P	P	P					
6	P	P	P					
7	P	P	P					
8	P	P	P					
9	P	P	P					
10	L	L	L					
11	P	P	P					
12	P	P	P					
13	P	P	P					
14	P	P	P					
15	P	P	P					
16	P	P	P					
17	P	P	P					
18	P	P	P					
19	P	P	P					
20	H	H	H					

NOTE: Logic probe readings taken with computer in Power Up mode (Main title screen displayed) unless otherwise noted.

Logic Probe Display
L = Low
H = High
P = Pulse

SAFETY PRECAUTIONS

1. Use an isolation transformer for servicing.

2. Maintain AC line voltage at rated input.

3. Remove AC power from the computer before servicing or installing electrostatically sensitive devices. Examples of typical ES devices are integrated circuits and semiconductor "chip" components.

4. Use extreme caution when handling the printed circuit boards. Some semiconductor devices can be damaged easily by static electricity. Drain off any electrostatic charge on your body by touching a known earth ground. Wear a commercially available discharging wrist strap device. This should be removed prior to applying power to the unit under test.

5. Use a grounded-tip, low voltage soldering iron.

6. Use an isolation (times 10) probe on scope.

7. Do not remove or install boards, floppy disk drives, printers, or other peripherals with computer AC power On.

8. Do not use freon-propelled sprays. These can generate electrical charges sufficient to damage semiconductor devices.

9. This computer is equipped with a grounded three-pronged AC plug. This plug must fit into a grounded AC power outlet. Do not defeat the AC plug safety feature.

10. Periodically examine the AC power cord for damaged or cracked insulation.

11. The computer cabinet is equipped with vents to prevent heat build-up. Never block, cover, or obstruct these vents.

12. Instructions should be given, especially to children, that objects should not be dropped or pushed into the vents of the cabinet. This could cause shock or equipment damage.

13. Never expose the computer to water. If exposed to water turn the unit Off. Do not place the computer near possible water sources.

14. Never leave the computer unattended or plugged into the AC outlet for long periods of time. Remove AC plug from AC outlet during lightning storms.

15. Do not allow anything to rest on AC power cord.

16. Unplug AC power cord from outlet before cleaning computer.

17. Never use liquids or aerosols directly on the computer. Spray on cloth and then apply to the computer cabinet. Make sure the computer is disconnected from the AC power line.
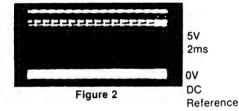
LINE DEFINITIONS

A0 Thru A15	Address Lines
A0D7 Thru A6D1	Combined Address and Data Lines
A3B Thru A14B	Buffered Address Lines
A15 CRU	Communications Register Unit Address 15
CAS	Column Address Strobe
CD0 Thru CD15	Converted Data Lines
CRU CLK	Communication Register Unit Clock
CRU IN	Communication Register Unit Data Input
CRU OUT	Communication Register Unit Data Output
CSR	Chip Select Video Display Processor Read
CSW	Chip Select Video Display Processor Write
D0 Thru D7	Bi-Directional Data Lines
DBIN	Data Bus Input
DLY RST	Delayed Reset
EXT INT	External Interrupt
GROM CLK	Graphics ROM Clock
IAQHA	Instruction Acquisition or Hold A
INT REQ	Interrupt Request
LOAD	CPU executes a Non-Maskable Interrupt
MBE	Memory Block Enable
MB4	Memory Block Four
MEMEN	Memory Enable
R/W	Read/Write
RAM BLK	RAM Blanking
RAS	Row Address Strobe
READY	Ready for Memory Access
RESET	Reset Computer and Peripherals
ROMEN	ROM Enable
RST 1	Reset
SBE	Speech Block Enable
SGC CLK	Central Processing Unit Clock
SND IN	Audio Input
SND OUT	Audio Output
SPEECH	Speech Synthesizer Input
SYS RDY	System Ready
VDP INT	Video Display Processor Interrupt
WE	Write Enable
Ø1	Phase One
Ø2	Phase Two
Ø3	Phase Three
Ø4	Phase Four

Any Bar above any alphabetical or numerical combination indicates line active in a low (0) state.

TROUBLESHOOTING

MICROPROCESSOR CHIP (CPU) OPERATION

Verify the processor is functioning by checking the signals on the address lines (pins 10 thru 24 of IC U600) and the data lines (pins 41 thru 56) using a logic probe or a scope. If a logic probe is used, refer to the "Logic Chart" for the correct readings. If a scope is used, the waveforms on the address lines (except pins 22 and 23 which have no signal in Power Up mode) should be similar to Figure 1. The waveforms on the data lines should be similar to Figure 2.

Figure 1

5V
2ms
0V
DC
Reference

Figure 2

5V
2ms
0V
DC
Reference

If the processor is not functioning, check the source voltages at pins 1, 2, 27, 33 and 59. Check the 48 MHz Oscillator Crystal (Y600) by checking the waveforms at pins 1 and 18 of IC U601. The frequency at pin 1 of IC U601 should measure 12.00MHz. Check the phase relationships of the Ø1, Ø2, Ø3 and Ø4 clocks at pins 12, 11, 8 and 9 of IC U601 (See Figure 3). Check the phase relationships of the Ø1, Ø2, Ø3 and Ø4 clocks at pins 14, 15, 7 and 6 of IC U601 (See Figure 4). Use a logic probe and check the readings at pins 4 thru 9, 25, 28, 29 and 61 thru 64 of IC U600 (See "Logic Chart").

Ø1 — PIN 12
Ø2 — PIN 11
Ø3 — PIN 8
Ø4 — PIN 9
U601
.2µs

Figure 3

Ø1 — PIN 14
Ø2 — PIN 15
Ø3 — PIN 7
Ø4 — PIN 6
U601
.2µs

Figure 4

CRYSTAL OSCILLATORS

Connect a frequency counter to pin 1 of IC U601 to check the 48 MHz oscillator. The frequency should read 12.00 MHz. Connect a frequency counter to pin 39 of IC U100 to check the 10.7 MHz oscillator. The frequency should read 10.738635 MHz. The frequency of the 10.7 MHz oscillator can be adjusted by Coil L100.

VIDEO SIGNALS

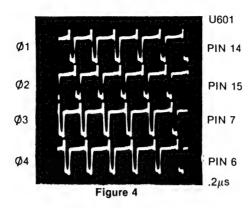Verify the operation of the video circuits by checking the waveforms at pin 36 of IC U100 and pin 4 of Jack J201. If the waveform is absent at pin 36 of IC U100, check the 10.7 MHz oscillator at pins 39 and 40 of IC U100 and check pins 1 thru 38 with a logic probe (See the "Logic Chart"). If the waveform at pin 4 of J201 is absent, check the voltages and components associated with Amp Transistor (Q200) and Predriver Transistor (Q201).

SOUND

Type in and run the following program if there is no sound. Check for a .7V p-p waveform at pin 7 of IC U511.

```
1 CALL SOUND (-400,200,2)
2 GOTO 1
```

If the waveform is present, check Capacitors C502, C503, C206 and C208 and Coil L201. If the waveform is absent, use a logic probe and check pins 1 thru 14 of IC U511. The readings should be the same as given in the "Logic Chart", except pin 6 will show pulses while the program is running. Check the clock waveform on pin 14 with a scope.

KEYBOARD

The computer comes up with the main title screen displayed on the monitor, but the keyboard has no effect when the keys are pressed. Check the waveforms on pins 1, 3, 6, 7, 9, 10, 11, 12 and 13 of IC U302 and pins 6, 7, 8, 9, 20, 31, 32, 33 and 34 of IC U300. Use a logic probe and check the readings on pins 1 thru 5, 10, 11, 17, 18, 24, 25, 35, 36, 39 and 40 of IC U300 (See "Logic Chart").

LOGIC (Continued)

PIN NO.	IC U507	IC U508	IC U509	IC U510	IC U511	PIN NO.	IC U600	PIN NO.	IC U600	PIN NO.	IC U600	PIN NO.	IC U600
1	P	P	L	L	P	1	L	21	P	41	P	61	P
2	P	P	P	L	P	2	H	22	L	42	P	62	
3	P	H	P	H	P	3	H	23	L	43	P	63	P
4	H	L	P	L	P	4	H	24	P	44	P	64	H
5	P	L	P	P	P	5	L	25	P	45	P		
6	H	H	P	P	H	6	H	26	P	46	P		
7	L	L	P	P	H(1)	7	P	27	H	47	P		
8	P	L	L	P	L	8	P	28	H	48	P		
9	P	P	P	L	L	9	P	29	P	49	P		
10	P	P	P	L	P	10	P	30	P	50	P		
11	P	P	P	P	P	11	P	31	P	51	P		
12	P	P	P	P	P	12	P	32	P	52	P		
13	P	P	P	P	P	13	P	33	H	53	P		
14	H	H	P	P	P	14	P	34	L	54	P		
15		L	P	L	P	15	P	35	L	55	P		
16		L	H	L	H	16	P	36	L	56	P		
17			H	L		17	P	37	L	57	*		
18			L	L		18	P	38	L	58	*		
19			L	H		19	P	39	L	59	H		
20			H			20	P	40	L	60	P		

PIN NO.	IC U601	IC U602	IC U603	IC U604	IC U605	IC U606	IC U607	IC U608	IC U609	IC U610	IC U611	IC U612	IC U613
1	L	P	P	P	L	P	H	L	L	P	P	H	P
2	L	P	P	P	L	P	H	P	P	P	P	P	P
3	L	P	P	P	P	P	P	P	P	P	P	P	L
4	H	P	P	P	P	L	P	P	P	P	P	P	L
5	H	P	P	*	L	P	P	P	P	P	P	P	L
6	H	P	P	L	P	P	P	P	P	P	P	P	*
7	P	P	L	L	L	P	L	P	P	P	P	L	*
8	P	P	L	L	P	P	P	P	P	P	P	H	L
9	P	P	P	P	P	P	P	P	P	P	P	L	P
10	L	P	P	H	P	P	H	H	H	P	P	L	P
11	P	P	P	P	P	P	H	P	P	L	L	P	P
12	P	P	P	P	H	P	L	L	L	L	P	P	
13	H	P	P	L	P	P	H	H	H	P	P	H	P
14	P	H	H	H	H	H	H	L	L	P	P	H	P
15	P				P			L	L	P	P		P
16	P			H				P	P	P	P		H
17	H							P	P	P	P		
18	L							P	P	P	P		
19	L							P	P	P	P		
20	H							P	P	P	P		
21								P	P	L	L		
22								P	P	P	P		
23								P	P	H	H		
24								H	H	H	H		

NOTE: Logic probe readings taken with computer in Power Up mode (Main title screen displayed) unless otherwise noted.

Logic Probe Display
L = Low

H = High
P = Pulse
* = Open (no light on)
(1) Probe will show P when sound is being produced.

LOGIC

PIN NO.	IC U100	PIN NO.	IC U100	PIN NO.	IC U102	IC U103	IC U104	IC U105	IC U106	IC U107	IC U108	IC U109
1	P	21	P	1	L	L	L	L	L	L	L	L
2	P	22	P	2	P	P	P	P	P	P	P	P
3	P	23	P	3	H	H	H	H	H	H	H	H
4	P	24	P	4	P	P	P	P	P	P	P	P
5	P	25	P	5	P	P	P	P	P	P	P	P
6	P	26	P	6	P	P	P	P	P	P	P	P
7	P	27	P	7	H	H	H	H	H	H	H	H
8	P	28	P	8	H	H	H	H	H	H	H	H
9	P	29	P	9	H	H	H	H	H	H	H	H
10	P	30	P	10	P	P	P	P	P	P	P	P
11	H	31	P	11	P	P	P	P	P	P	P	P
12	L	32	P	12	P	P	P	P	P	P	P	P
13	P	33	H	13	P	P	P	P	P	P	P	P
14	H	34	H	14	P	P	P	P	P	P	P	P
15	P	35	H	15	P	P	P	P	P	P	P	P
16	P	36	P	16	L	L	L	L	L	L	L	L
17	P	37	P	17								
18	P	38	P	18								
19	P	39	P	19								
20	P	40	P	20								

PIN NO.	IC U300	PIN NO.	IC U300	PIN NO.	IC U302	IC U500	IC U501	IC U502	IC U503	IC U504	IC U505	IC U506
1	H	21	P	1	P	P	P	P	L	L	P	P
2	P	22	P	2	L	P	P	P	L	L	P	P
3	P	23	H	3	P	P	P	P	P	L	P	P
4	P	24	P	4	P	P	P	P	P	P	P	P
5	P	25	P	5	H	P	P	P	P	L	P	P
6	H(2)	26	P	6	P	P	P	P	P	H	P	P
7	H(3)	27	L	7	P	P	P	P	P	H	P	L
8	H(4)	28	*(10)	8	L	P	P	P	L	L	L	L
9	H(5)	29	H	9	P	H	H	H	P	H	P	H
10	P	30	L(11)	10	P	P	P	P	P	H	P	P
11	P	31	H(6)	11	P	P	P	P	P	H	H	P
12	P	32	H(7)	12	P	P	P	P	P	H	H	P
13	H	33	H(8)	13	P	P	P	P	P	H	P	P
14	P	34	H(9)	14	L	L	L	L	P	H	H	H
15	P	35	P	15	P	P	P	P	P	L	H	
16	L	36	P	16	H	L	L	L	H	H	H	
17	H	37	*	17								
18	P	38	L	18								
19	H	39	P	19								
20	H	40	H	20								

NOTE: Logic probe readings taken with computer in Power Up mode (Main title screen displayed) unless otherwise noted.

Logic Probe Display
L = Low
H = High
P = Pulse
* = Open (no light on)
(2)   Probe will show P when the 6 key is pressed.

(3)   Probe will show P when the Y key is pressed.
(4)   Probe will show P when the H key is pressed.
(5)   Probe will show P when the N key is pressed.
(6)   Probe will show P when the Z key is pressed.
(7)   Probe will show P when the Q key is pressed.
(8)   Probe will show P when the A key is pressed.
(9)   Probe will show P when the 2 key is pressed.
(10) Probe will show P when saving program to tape.
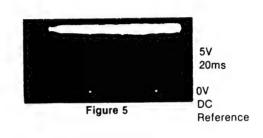(11) Probe will show P when loading program from tape.
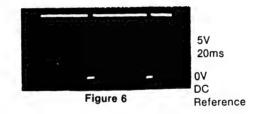

TROUBLESHOOTING (Continued)

JOYSTICKS

Type in and run the following program if the keys on the keyboard function but the joysticks do not. Check for the waveform shown in Figure 5 at the emitters of Joystick Control 1 and 2 Transistors (Q300 and Q301).

```
1 CALL JOYST (1, X, Y)
2 CALL JOYST (2, X, Y)
3 CALL KEY (1, X, Y)
4 CALL KEY (2, X, Y)
5 GOTO 1
```

The waveform shown in Figure 6 should appear at the emitters of Transistors Q300 and Q301 when the fire button is pressed. Transistor Q300 controls Joystick 1 and Transistor Q301 controls Joystick 2. If either waveform is absent, check the voltages and components associated with the transistor with the missing waveform.

Figure 5
5V
20ms
0V
DC Reference

Figure 6
5V
20ms
0V
DC Reference

CASSETTE RECORDER

NOTE: Verify the recorder used can be turned On and Off by a computer in good working order. CS1 is the recorder connected to the three plug cassette cable. CS2 is the recorder connected to the two plug cassette cable.

The computer will not turn On CS1. Check the voltages and components associated with the Control Output Transistor (Q401), LED Driver Transistor (Q402) and Opto-isolator U401.

The computer will not turn Off CS1. Check for .02V at pin 19 of IC U300 when the recorder should be Off. If the voltage is good, check Transistor Q401, Transistor Q402 and Opto-isolator U401.

The computer will not turn On CS2. Check the voltages and components associated with the Control Output Transistor (Q403), LED Driver Transistor (Q404) and Opto-isolator U402.

The computer will not turn Off CS2. Check for .02V at pin 23 of IC U300 when the recorder should be Off. If the voltage is good, check Transistors Q403 and Q404 and Optoisolator U402.

The computer will not load a program. Check the waveforms at pin 8 of Jack J400, pin 7 of IC U400 and pin 30 of IC U300 while loading a program. NOTE: The amplitude of the waveforms depends on the volume control setting of the recorder. If the waveform at pin 8 of J400 is absent, check Capacitor C402 and check for possible shorts to ground. If the waveform at pin 7 of IC U400 is absent, check the voltages and components associated with pins 4, 6, 7 and 8 of IC U400. If the waveform at pin 30 of IC U300 is absent, check the voltages and components associated with pins 1, 2, 3, 4 and 8 of IC U400.

The computer will not save a program. Check the waveform at pin 28 of IC U300 while saving a program. If the waveform is good, check Capacitors C400, C403 and C407 and Resistors R400, R401 and R402.

RF MODULATOR

Verify the RF Modulator is getting the proper voltages and signals by checking for 11.78V at the red wire from the cable, 1.95V at the yellow wire and .54V at the clear wire. The clear wire should also have a 1V p-p video signal.

ADJUSTMENT

10.7 MHz OSCILLATOR

Connect the input of a frequency counter to pin 39 of IC U100 and adjust Coil L100 for a frequency of 10.738635 MHz.

SEMICONDUCTORS (Select replacement for best results)

ITEM No.	TYPE No.	MFGR. PART No.	ECG PART No.	GENERAL ELECTRIC PART No.	MOTOROLA PART No.	NTE PART No.	RCA PART No.	WORKMAN PART No.	ZENITH PART No.
CR1 thru CR5	1N4003		ECG116	GE-504A	1N4003	NTE116	SK3311	WEP156	212-76-02
	1N4002		ECG116	GE-504A	1N4002	NTE116	SK3311	WEP155	212-76-02
CR7	1N4148F		ECG519	GE-514	1N4935	NTE519	SK3100/519	WEP925/519	103-131
	PG1992		ECG519	GE-514	1N4935	NTE519	SK3100/519	WEP925/519	103-131
CR8	1N528		ECG5013A	GEZD-6.2	1N5234B	NTE5013A	SK6A2/5013A	WEP1414/5013	103-Z9008
CR9	V331X		ECG552	GE-511		NTE552	SK9000/552	WEP172/506	103-287
CR10	1N4148F		ECG519	GE-514	1N4935	NTE519	SK3100/519	WEP925/519	103-131
	PG1992		ECG519	GE-514	1N4935	NTE519	SK3100/519	WEP925/519	103-131
CR200,1	1N4148F		ECG519	GE-514	1N4935	NTE519	SK3100/519	WEP925/519	103-131
	1N4148		ECG519	GE-514	1N4935	NTE519	SK3100/519	WEP925/519	103-131
CR402	1N4148		ECG519	GE-514	1N4935	NTE519	SK3100/519	WEP925/519	103-131
CR500	PG1992		ECG519	GE-514	1N4935	NTE519	SK3100/519	WEP925/519	103-131
	1N4148		ECG519	GE-514	1N4935	NTE519	SK3100/519	WEP925/519	103-131
CR501,2	PG1992		ECG519	GE-514	1N4935	NTE519	SK3100/519	WEP925/519	103-131
	1N4148		ECG519	GE-514	1N4935	NTE519	SK3100/519	WEP925/519	103-131
	1N914B		ECG177	GE-300	1N4935	NTE177	SK9091/177	WEP1062/177	103-131
Q1	578-2303		ECG159	GE-82	2N5401	NTE159	SK3466/159	WEP62/159	121-Z9003
	T1S93		ECG159	GE-82	2N5401	NTE159	SK3466/159	WEP62/159	121-Z9003
Q2	T1P31A		ECG291	GE-302	MJE15030	NTE291	SK3893/152	WEP780/291	121-Z9047
	TIP31		ECG291	GE-302	MJE15030	NTE291	SK3893/152	WEP780/291	121-Z9047
Q200	2N3906		ECG159	GE-82	2N5401	NTE159	SK3466/159	WEP62/159	121-Z9003
Q201	2472222		ECG123AP	GE-123AP	MPSA05	NTE123AP	SK3854/123A	WEP736/123A	121-Z9000A
	2N2222		ECG123A	GE-20	MPSA05	NTE123A	SK3444/123A	WEP736/123A	121-Z9000A
Q300,1	501-4249		ECG123AP	GE-123AP	MPSA05	NTE123AP	SK3854/123A	WEP736/123A	121-Z9000A
Q400 thru Q404	501-4249		ECG123AP	GE-123AP	MPSA05	NTE123AP	SK3854/123A	WEP736/123A	121-Z9000A
	T1S92		ECG123AP	GE-123AP	MPSA05	NTE123AP	SK3854/123A	WEP736/123A	121-Z9000A
Q500	501-4249		ECG123AP	GE-123AP	MPSA05	NTE123AP	SK3854/123A	WEP736/123A	121-Z9000A
	T1S92		ECG123AP	GE-123AP	MPSA05	NTE123AP	SK3854/123A	WEP736/123A	121-Z9000A
U1	78M12C		ECG966	GEVR-111	MC7812CT	NTE966	SK3592/966	WEP966L/966	HE-442-674
U2	UA7812C		ECG966	GEVR-111	MC7812CT	NTE966	SK3592/966	WEP966L/966	HE-442-674
	UA79M05C		ECG961	GE-961	MC7905CT	NTE961	SK3671/961		HE-442-630

REPLACEMENT DATA

**TEXAS INSTRUMENTS
TI-99/4A MODEL PHC004A**

PARTS LIST AND DESCRIPTION (Continued)

When ordering parts, state Model, Part No., and Description

TRANSFORMER (Power)

ITEM No.	RATING			REPLACEMENT DATA		
	PRI.	SEC. 1	SEC. 2	MFGR. PART No.	THORDARSON PART No.	NOTES
T1	120V AC @ 270mA AC	26.40V AC @ 686mA DC Tapped @ 17.85V AC @ 600mA DC				

MISCELLANEOUS

ITEM No.	PART NAME	MFGR. PART No.	NOTES
CR6	LED		TIL220
M1			RF Modulator
S1 Thru S48	Switch		Part of Keyboard
S1A	Switch		Power
Y100	Crystal		10.7MHz
Y600	Crystal		48MHz

CABINETS & CABINET PARTS (When ordering specify model, chassis & color)

WIRING DATA

General-use Unshielded Hook-up Wire	Use BELDEN No. 8529 (Solid) Available in 13 Colors
	8522 (Stranded) Available in 13 Colors
300-Ohm Input Lead	Use BELDEN No. 8225
75-Ohm Input Lead	Use BELDEN No. 8241

PARTS LIST AND DESCRIPTION (Continued)

When ordering parts, state Model, Part No., and Description

ELECTROLYTIC CAPACITORS

ITEM No.	RATING	MFGR. PART No.
C7	47 16V 20%	
C8	1000 25V 20%	
C9	3300 35V 20%	
C10	47 16V 20%	
C12	4.7 35V 20%	
C15	470 12V	
C103	100 16V 20%	
C128	22 25V	

ITEM No.	RATING	MFGR. PART No.
C129	22 25V 20%	
C130	22 25V	
C201	10 16V 20%	
C503	100 16V 20%	
C506	22 25V	
C600	100 16V 20%	
C605	1	
C606	22 25V 20%	

RESISTORS (Power and Special)

ITEM No.	RATING	REPLACEMENT DATA MFGR. PART No.	REPLACEMENT DATA WORKMAN PART No.	REMARKS
R500	Resistor Network	1501633-8 (1)		

(1) Number on unit.

COILS (RF-IF)

ITEM No.	FUNCTION	MFGR. PART No.
L1	RF Choke (90uH)	
L2	RF Choke (90uH)	
L3	RF Choke (90uH)	
L4	RF Choke (1mH)	
L5	RF Choke (8.2uH)	
L6	RF Choke (8.2uH)	
L100	Oscillator (2-4.5uH)	
L101	RF Choke (6.8uH)	
L102	RF Choke (6.8uH)	
L103	RF Choke (6.8uH)	
L104	RF Choke (6.8uH)	
L105	RF Choke	
L106	RF Choke	
L107	Peaking	
L108	RF Choke	
L109	RF Choke	
L110	RF Choke	
L111	RF Choke	
L112	RF Choke (6.8uH)	
L113	RF Choke (6.8uH)	
L114	RF Choke (6.8uH)	

ITEM No.	FUNCTION	MFGR. PART No.
L115	RF Choke	
L200	RF Choke (6.8uH)	
L201	Peaking (6.8uH)	
L202	Peaking (22uH)	
L203	Peaking (8.2uH)	
L308	Peaking (6.8uH)	
L309	Peaking (6.8uH)	
L310	Peaking (6.8uH)	
L311	Peaking (6.8uH)	
L312	Peaking (6.8uH)	
L313	Peaking (6.8uH)	
L400	Peaking	
L401	Peaking	
L402	Peaking	
L403	Peaking	
L500	RF Choke (6.8uH)	
L501	RF Choke	
L600	RF Choke (6.8uH)	
L602	Peaaking (.33uH)	
L603	RF Choke (6.8uH)	
L604	RF Choke (6.8uH)	

PARTS LIST AND DESCRIPTION (Continued)

When ordering parts, state Model, Part No., and Description

SEMICONDUCTORS (Select replacement for best results) (cont)

ITEM No.	TYPE No.	MFGR. PART No.	ECG PART NO.	GENERAL ELECTRIC PART NO.	MOTOROLA PART NO.	NTE PART NO.	RCA PART NO.	WORKMAN PART NO.	ZENITH PART NO.
U3	UA723CN		ECG923D	GEIC-260	MC1723CP	NTEE923D	SK3165/923D	WEP2331/923D	221-Z9020
U4	UA723C		ECG923D	GEIC-260	MC1723CP	NTEE923D	SK3165/923D	WEP2331/923D	221-Z9020
	TL331CP								
	TL331								
U100	TMS9918ANL		ECG2117			NTE2117			HE-443-904
	TMS9918A		ECG2117			NTE2117			HE-443-904
U102 thru U109	D416C								
	TMS4116								
U300	TMS9901NL								
	TMS9901								
U302	SN74LS156N		ECG74LS156N			NTE74LS156			
U400	RC4558P		ECG778A	GEIC-220	MC1458CP1	NTE778A	SK3465/778A	WEP2053/778A	221-Z9034
	4558		ECG778A	GEIC-220	MC1458CP1	NTE778A	SK3465/778A	WEP2053/778A	221-Z9034
U401,2	TIL119		ECG3044		TIL119	NTE3044			
U500	CD2155NL								
	TMC0430								
U501	CD2156NL								
	TMC0430								
U502	CD2157NL								
U503	SN74LS367AN		ECG74LS367		SN74LS367AN	NTE74LS367	SK74LS367		HE-443-857
	74LS367		ECG74LS367		SN74LS367AN	NTE74LS367	SK74LS367		HE-443-857
U504,5	SN74LS138N		ECG74LS138		SN74LS138N	NTE74LS138	SK74LS138		HE-443-877
	74LS138		ECG74LS138		SN74LS138N	NTE74LS138	SK74LS138		HE-443-877
U506	SN74LS03N		ECG74LS03		SN74LS03N	NTE74LS03	SK74LS03		HE-443-745
	74LS03		ECG74LS03		SN74LS03N	NTE74LS03	SK74LS03		HE-443-745
U507	SN74LS32N		ECG74LS32		SN74LS32N	NTE74LS32	SK74LS32		HE-443-875
	74LS32		ECG74LS32		SN74LS32N	NTE74LS32	SK74LS32		HE-443-875
U508	SN74LS04N		ECG74LS04		SN74LS04N	NTE74LS04	SK74LS04		HE-443-755
	74LS04		ECG74LS04		SN74LS04N	NTE74LS04	SK74LS04		HE-443-755
U509	SN74LS367AN		ECG74LS367		SN74LS367AN	NTE74LS367	SK74LS367		HE-443-857
	74LS367		ECG74LS367		SN74LS367AN	NTE74LS367	SK74LS367		HE-443-857
U510	SN74LS244N		ECG74LS244		SN74LS244N	NTE74LS244	SK74LS244		HE-443-791
	74LS244		ECG74LS244		SN74LS244N	NTE74LS244	SK74LS244		HE-443-791

PARTS LIST AND DESCRIPTION (Continued)

When ordering parts, state Model, Part No., and Description

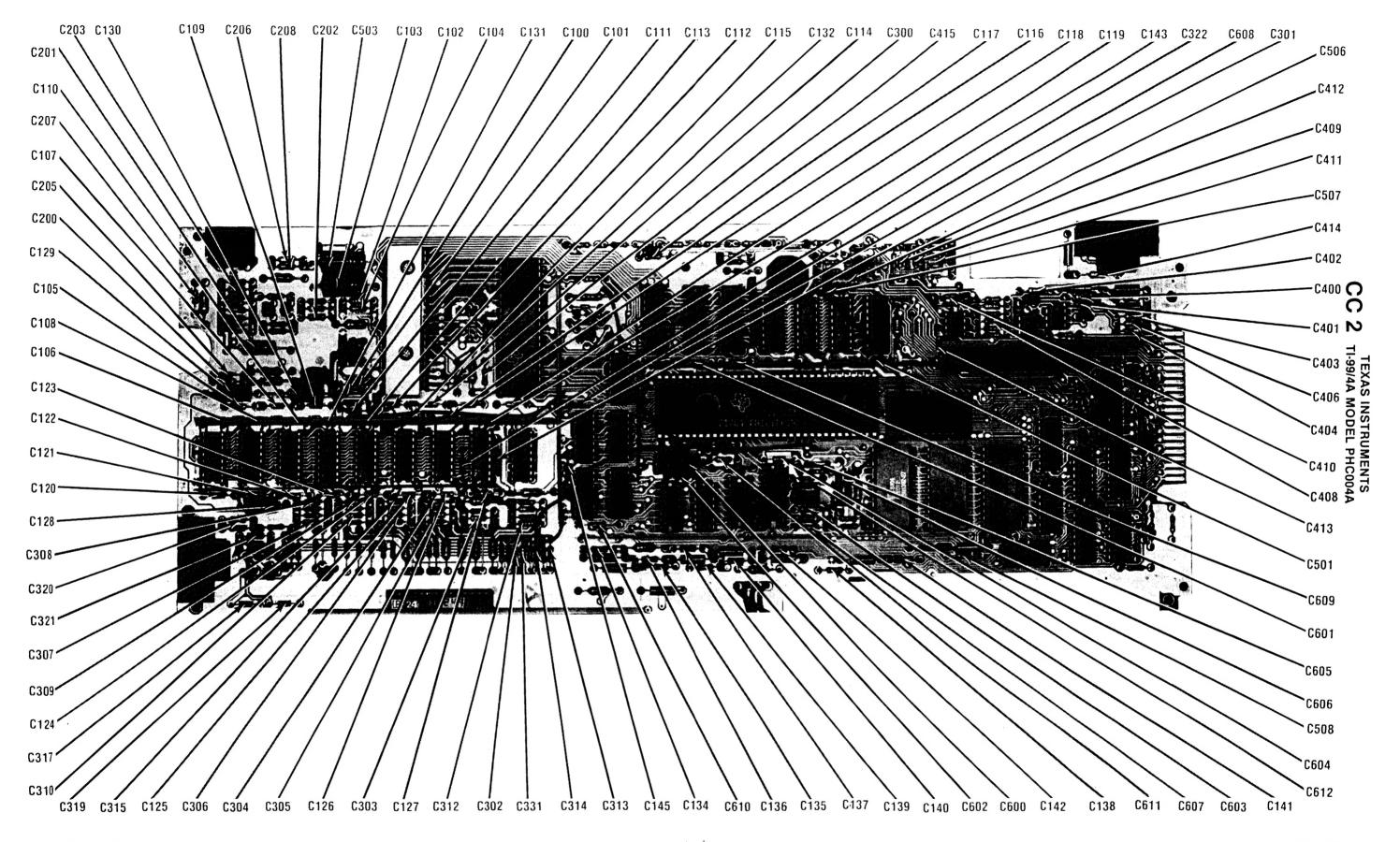### SEMICONDUCTORS (Select replacement for best results) (cont)

ITEM No.	TYPE No.	MFGR. PART No.	ECG PART No.	GENERAL ELECTRIC PART No.	MOTOROLA PART No.	NTE PART No.	RCA PART No.	WORKMAN PART No.	ZENITH PART No.
U511	SN94624N								
U600	TMS9919								
U601	TMS9900NL								
	TMS9900								
	TIM9904ANL								
	74LS362								
U602	SN74LS04N		ECG74LS04		SN74LS04N	NTE74LS04	SK74LS04		HE-443-755
	74LS04		ECG74LS04		SN74LS04N	NTE74LS04	SK74LS04		HE-443-755
U603	SN74LS00N		ECG74LS00		SN74LS00N	NTE74LS00	SK74LS00		HE-443-728
	74LS00		ECG74LS00		SN74LS00N	NTE74LS00	SK74LS00		HE-443-728
U604	SN74LS04N		ECG74LS04		SN74LS04N	NTE74LS04	SK74LS04		HE-443-755
	74LS04								
U605	SN74LS32N		ECG74LS32		SN74LS32N	NTE74LS32	SK74LS32		HE-443-875
	74LS32		ECG74LS32		SN74LS32N	NTE74LS32	SK74LS32		HE-443-875
U606	SN74LS00N		ECG74LS00		SN74LS00N	NTE74LS00	SK74LS00		HE-443-728
	74LS00		ECG74LS00		SN74LS00N	NTE74LS00	SK74LS00		HE-443-728
U607	SN74LS74AN		ECG74LS74A		SN74LS74AN	NTE74LS74A	SK74LS74		HE-443-730
	74LS74		ECG74LS74A		SN74LS74AN	NTE74LS74A	SK74LS74		HE-443-730
U608,9	MCM6810P		ECG6810		MCM6810P	NTE6810			
U610	CD3226A-NL								
	TMS4732/2532								
	C2E012/8304								
	TMS4732/2532								
U611									
U612	SN74LS00N		ECG74LS00		SN74LS00N	NTE74LS00	SK74LS00		HE-443-728
	74LS00		ECG74LS00		SN74LS00N	NTE74LS00	SK74LS00		HE-443-728
U613	SN74LS194AN					NTE74LS194			
	74LS194								
U614	SN74LS245N		ECG74LS245		SN74LS245N	NTE74LS245	SK74C245		HE-443-885
	74LS245		ECG74LS245		SN74LS245N	NTE74LS245	SK74C245		HE-443-885
U615	SN74LS373N		ECG74LS373		SN74LS373N	NTE74LS373			HE-443-867
	74LS373		ECG74LS373		SN74LS373N	NTE74LS373			HE-443-867
U616	SN74LS244N		ECG74LS244		SN74LS244N	NTE74LS244	SK74LS244		HE-443-791
	74LS244		ECG74LS244		SN74LS244N	NTE74LS244	SK74LS244		HE-443-791

PARTS LIST AND DESCRIPTION (Continued)

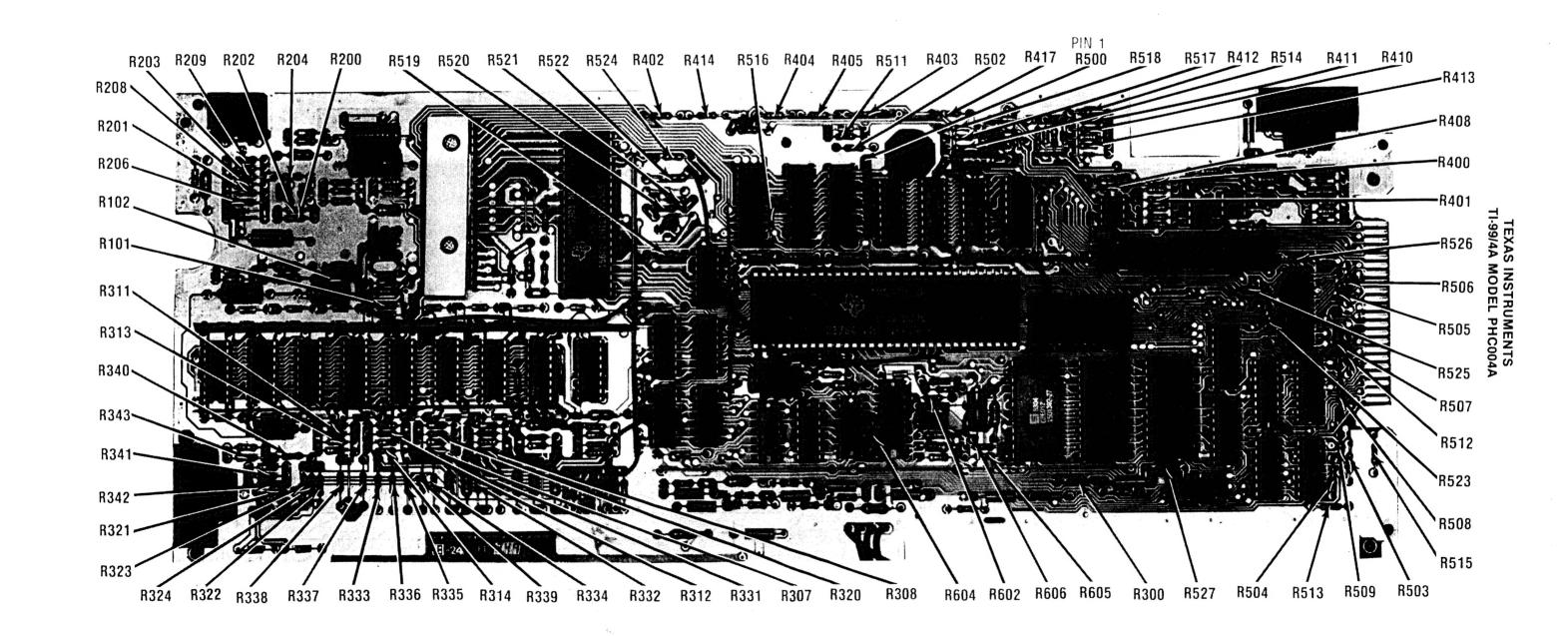When ordering parts, state Model, Part No., and Description

CAPACITORS

ITEM No.	RATING	MFGR. PART No.
C1	.1 50V	
C2	.1 50V	
C3	.1 50V	
C4	.1 50V	
C6	.1 50V	
C11	100 50V 5%	
C13	.1 50V	
C14	.1 50V	
C16	.1	
C17	.1 50V	
C18	.1 50V	
C100	56 NPO 50V 5%	
C101	12 NPO 50V 5%	
C102	.001 50V 10%	
C104	.01 25V	
C105	.1 50V	
C106	.1 50V	
C107	.1 50V	
C108	.1 50V	
C109	.1 50V	
C110	.1 50V	
C111	.1 50V	
C112	.1 50V	
C113	.1 50V	
C114	.1 50V	
C115	.1 50V	
C116	.1 50V	
C117	.1 50V	
C118	.1 50V	
C119	.1 50V	
C120	.1 50V	
C121	.1 50V	
C122	.1 50V	
C123	.1 50V	
C124	.1 50V	
C125	.1 50V	
C126	.1 50V	
C127	.1 50V	
C131	.1 50V	
C132	.01 25V	
C134	.01 25V	
C135	.01 25V	
C136	.01 25V	
C137	.01 25V	
C138	.01 25V	
C139	.01 25V	
C140	.01 25V	
C141	.01 25V	
C142	.01 25V	
C143	.01 25V	
C145	.01 25V	
C200	82 50V 5%	
C202	.01 25V	
C203	.01 25V	
C205	.1 50V	
C206	.001 50V 10%	
C207	.1 50V	

ITEM No.	RATING	MFGR. PART No.
C208	.01 25V	
C300	.01 25V	
C301	.01 25V	
C302	.001 50V 10%	
C303	.001 50V 10%	
C304	.001 50V 10%	
C305	.001 50V 10%	
C306	.001 50V 10%	
C307	.001 50V 10%	
C308	.001 50V 10%	
C309	.001 50V 10%	
C310	.001 50V 10%	
C311	.001 50V 10%	
C312	.001 50V 10%	
C313	.001 50V 10%	
C314	.001 50V 10%	
C315	.001 50V 10%	
C317	.1 50V	
C319	.1 50V	
C320	.001 50V 10%	
C321	.001 50V 10%	
C322	.1 50V	
C331	.001 50V 10%	
C400	.001 50V 10%	
C401	.001 50V 10%	
C402	.001 50V 10%	
C403	.001 50V 10%	
C404	.001 50V 10%	
C405	.001 50V 10%	
C406	.001 50V 10%	
C407	.001 50V 10%	
C408	.01 25V	
C409	.01 15V 5%	
C410	.022 15V 5%	
C411	220 50V 10%	
C412	.1 50V	
C413	.1 50V	
C414	.001 50V 10%	
C415	.01 25V	
C500	.01 25V	
C501	.1 50V	
C502	.1 50V	
C505	.1 50V	
C507	.01 25V	
C508	.1 50V	
C601	.001 50V 10%	
C602	.01 25V	
C603	47 NPO 50V 5% 22 50V	
C604	.1 50V	
C607	.001 50V 10%	
C608	.1 50V	
C609	.1 50V	
C610	.1 50V	
C611	.001 50V 10%	
C612	.1 50V	

TEXAS INSTRUMENTS
TI-99/4A MODEL PHC004A

C203 C130 C109 C206 C208 C202 C503 C103 C102 C104 C131 C100 C101 C111 C113 C112 C115 C132 C114 C300 C415 C117 C116 C118 C119 C143 C322 C608 C301

C201
C110
C207
C107
C205
C200
C129
C105
C108
C106
C123
C122
C121
C120
C128
C308
C320
C321
C307
C309
C124
C317
C310

C506
C412
C409
C411
C507
C414
C402
C400
C401
C403
C406
C404
C410
C408
C413
C501
C609
C601
C605
C606
C508
C604
C612

CC 2

TEXAS INSTRUMENTS
TI-99/4A MODEL PHC004A

C319 C315 C125 C306 C304 C305 C126 C303 C127 C312 C302 C331 C314 C313 C145 C134 C610 C136 C135 C137 C139 C140 C602 C600 C142 C138 C611 C607 C603 C141

MAIN BOARD

MAIN BOARD

TEXAS INSTRUMENTS
TI-99/4A MODEL PHC004A

R203 R209 R202 R204 R200 R519 R520 R521 R522 R524 R402 R414 R516 R404 R405 R511 R403 R502 R417 R500 R518 R517 R412 R514 R411 R410

PIN 1

R208
R201
R206
R102
R101
R311
R313
R340
R343
R341
R342
R321
R323

R413
R408
R400
R401
R526
R506
R505
R525
R507
R512
R523
R508
R515

R324 R322 R338 R337 R333 R336 R335 R314 R339 R334 R332 R312 R331 R307 R320 R308 R604 R602 R606 R605 R300 R527 R504 R513 R509 R503

MAIN BOARD

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SAMS

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COMPUTERFACTS™ put easy to use, informative technical data right at your fingertips. Each edition includes specific service information on the individual component, along with some overall troubleshooting hints.

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- Preliminary Service Checks section is an easy to use, step by step guide for the experienced technician or hobbyist, and even beginners.

- SAMS famous industry accepted standardized notation schematics containing CIRCUITRACE®, GRIDTRACE™, waveforms, voltages and stage identification.
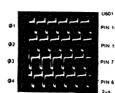
- Step by Step Troubleshooting guides the technician through the necessary procedures to quickly locate the problem.

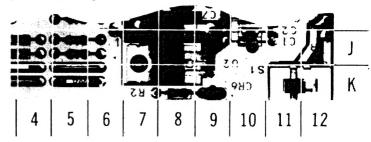**TROUBLESHOOTING**

MICROPROCESSOR CHIP (CPU) OPERATION

Verify the processor is functioning by checking the signals on the address lines (pins 10 thru 24 of IC U600) and the data lines (pins 41 thru 56) using a logic probe or a scope. If a logic probe is used, refer to the "Logic Chart" for the correct readings. If a scope is used, the waveforms on the address lines (except pins 22 and 23 which have no signal in Power Up mode) should be similar to Figure 1. The waveforms on the data lines should be similar to Figure 2

- Logic Chart containing logic probe readings to isolate defective circuitry and components.

LOGIC

PIN NO.	IC U100	PIN NO.	IC U100	PIN NO.	IC U102	IC U103	IC U104	IC U105	IC U106	IC U107	IC U108	IC U109
1	P	21	P	1								
2	P	22	P	2	L	L	L	L	L	L	L	L
3	P	23	P	3	P	P	P	P	P	P	P	P
					H	H	H	H	H	H	H	H

- Quick Component Location using the SAMS exclusive GRIDTRACE, CIRCUITRACE, and component photographs.

- Complete Components Parts List in an easy to use format with field replacements shown when possible. SAMS unique semiconductor, chip and IC cross-reference gives you many replacements to choose from and is available at your Electronic Distributor.

SEMICONDUCTORS (Select replacement for best results)

ITEM No.	TYPE No.	MFGR. PART No.	REPLACEMENT DATA						
			ECG PART No.	GENERAL ELECTRIC PART No.	MOTOROLA PART No.	NTE PART No.	RCA PART No.	WORKMAN PART No.	ZENITH PART No.
D102	1SS53	1149-2576	ECG519	GE-514	1N4935	NTE519	SK9091/177	WEP925/519	103-131
D103	1N60FM	1149-2527	ECG109	1N60		NTE109	SK3088	WEP134/109	103-Z9001
D201	1N4004GP	1201-4205	ECG116	GE-504A	1N4004	NTE116	SK3312	WEP157	212-76-02
D501 thru	1SS53	1149-2576	ECG519	GE-514	1N4935	NTE519	SK9091/177	WEP925/519	103-131
D503									

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